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THE USE OF POLLEN TRAPS AND POLLEN SUPPLEMENTS IN DEVELOPING HONEYBEE COLONIES 1/

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The lack of sufficient pollen is a serious handicap in wintering and in developing colonies from packages in time for the honey flow. Investigations during the last 10 years have shown that winter brood rearing is both normal and desirable. The surviving populations of overwintered colonies are proportional to the amount of their fall pollen reserves when colonies with normal populations are headed by good queens and provided with adequate honey stores. Pollen collection early in the spring may be light or intermittent, owing to inclement weather. A lack of reserve pollen or of dependable field sources prevents package colonies from being established sufficiently early to allow the necessary time for them to reach maximum strength for a June honey flow.

The object of all beekeeping practices is to have maximum producing populations during honey-flow periods. Brood rearing is the basis for colony development. The amount of brood reared is dependent upon the queen's capacity to lay eggs, the supporting population of bees to provide brood-rearing temperatures and care for the brood, an adequate reserve of both pollen and honey, and comb space properly arranged to allow the queen and bees to expand brood production to full capacity. The development of maximum populations is dependent upon the rate of brood rearing, the length of time for development, and the length of life of the adult bees.

No satisfactory complete substitute for pollen has been found. Cane or beet sugar can be fed as a syrup to meet deficiencies in the honey supply, and the other basic requirements for brood production can be provided. Pollen deficiencies during critical periods in colony development therefore present a major problem in the productive management of colonies.

1/ A contribution from the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, in cooperation with the University of Wisconsin.

A good colony requires 40 to 50 or more pounds (6 to 8 gallons) of pollen in maintaining optimum brood rearing during a calendar year. The amount which a colony collects is determined by its population of worker bees when plants are yielding pollen and the abundance and location of these plants within the flight range of the colony. Observations have shown that, during periods of pollen scarcity, not all colonies in an apiary will locate and collect pollen from the same source, with the result that colonies of equivalent strength may collect larger or smaller quantities. The accumulation of pollen reserves within the colony is dependent upon the quantity of pollen available, the colony strength, the balance between brood production and population, and the selective collecting activity of the bees. Queenless colonies, or those with failing queens, accumulate larger pollen reserves, provided a good source is available in the field, because the pollen collected is not required for feeding the normal quantity of brood.

Efforts to increase the storage of pollen reserves through colony manipulations are in general inadequate. In some seasons, and in some localities, colonies may be made queenless temporarily during heavy pollen-yielding periods without sacrificing the honey crop or the colony populations required for good wintering. Colonies operated under the two-queen system of management, when united and returned to a single-queen status, have an excess population in relation to their brood rearing which results in the accumulation of pollen reserves comparable with those of queenless colonies. Success with these practices depends upon timing the manipulation with an abundant pollen supply in the field during periods when it will not sacrifice the honey crop or the colony for wintering. Extra storage space for pollen may be provided by placing a super of dark brood combs underneath the active brood nest, which helps to concentrate the pollen reserves.

The preceding interpretation of important aspects of the pollen problem has been given as a background to the recommendations which are the basis for this circular. A brief summary of experimental tests is followed by directions for feeding colonies deficient in pollen during critical brood-rearing periods. This is done for the purpose of continuity, even though it is recognized that pollen must be collected before it can be fed with supplements. The description of a pollen trap and its use are given at the end, since at present there are no commercial sources where pollen for feeding can be purchased.

Preliminary experiments to determine the brood rearing value of different types of pollen, and other protein foods resembling pollen in composition, have shown that soybean flour has value as a supplement to pollen even though it is not a complete substitute. The experimental tests since 1938 have shown sufficient practical value to warrant the feeding of soybean flour, supplemented with 25 percent of pollen, to overwintered or package colonies. This feeding should be done early in the spring when colony development is curtailed because of lack of pollen reserves or the intermittent collection of pollen from the field.

It is not the purpose of this circular to present the detailed experiments. However, a brief summary of some results is useful. A series of 18 colonies headed by sister queens of uniform stock were maintained, under greenhouse conditions, in individual compartments enclosed by cheesecloth. The average numbers of bees produced from the colonies fed with the different combinations of pollen and soybean flour between December 12, 1939, and January 30, 1940, were as follows:

Food of bees from December 12 to January 30	Average number of bees produced per test colony
Honey alone (checks)	575
Honey plus cakes of soybean flour	2,600
Honey plus cakes of soybean flour and 12.5% of pollen	4,900
Honey plus cakes of soybean flour and 25% of pollen	5,500
Honey plus cakes of soybean flour and 50% of pollen	7,300
Honey plus cakes of pollen alone	8,600

The queens in all colonies continued laying throughout the period, even though brood rearing did not continue for the entire period in the first two groups. The pollen and soybean flour and their combinations were fed as moist doughlike cakes prepared by mixing the dry foods with sugar syrup.

These averages are not entirely significant, because the best colony in each group reared approximately as much brood as the average for the group above it. The best colony receiving soybean flour with 50 percent of pollen reared as much brood as the best colony receiving pollen alone. The differences in brood production among groups receiving pollen or soybean flour were not great during the first 12-day sealed-brood cycle. However, colonies receiving soybean flour as a complete substitute curtailed active brood rearing soon after a 10- to 14-day period, whereas those receiving soybean flour supplemented by pollen continued to maintain brood rearing. Strong outdoor-wintered colonies given soybean flour continued active brood rearing for longer periods than smaller colonies used in the greenhouse. All these observations suggest that colonies rearing brood from soybean flour utilize food reserves stored within the body tissues of the worker bees to supplement the nutrients obtained from the flour.

Overwintered colonies lacking pollen reserves have responded in brood rearing when cakes of soybean flour supplemented with 25 percent of pollen were fed during February, March, and April, before pollen was available in the field. They reared considerably more brood than the experimental colonies under greenhouse conditions. Two-pound packages established during the first week of March in 1939 and in 1940 produced brood in amounts similar to those colonies in the greenhouse when fed the respective test foods.

The "cakes" of pollen or soybean flour are consumed more rapidly when young bees emerge than when a similar number of larvae are reared without the presence of emerging bees. Based upon the air-dry weight of pollen

and soybean flour, approximately 0.092 gram of pure pollen, 0.078 gram of 50 percent of pollen, 0.062 gram of 25 or 12.5 percent of pollen, and 0.049 gram of pure soybean flour were consumed for each bee reared in the respective groups. Most pollens contain from 20 to 25 percent of protein, while the soybean flour fed contained from 50 to 52 percent. There is an inverse relationship between the amount of dry food required per bee reared and the total number of bees reared from the respective foods and their combinations. This relationship suggests that pollen is more palatable to the bees, and soybean flour more nutritious, although lacking in some essential food elements present in pollen.

Preparation and Feeding of Soybean Cakes Supplemented with Pollen

Soybean and pollen cakes are satisfactory when fed for immediate use in brood rearing but they cannot be used to build up fall pollen reserves. Beekeeping practice should be directed toward building up maximum pollen reserves in colonies to be wintered. Normal colonies under northern conditions will consume 500 or more square inches of pollen, to advantage, during winter and early-spring brood rearing. This amount of pollen represents the equivalent of from four to six well-filled pollen combs, commonly referred to as pollen-clogged combs. Where colonies fall short of adequate pollen reserves, soybean and pollen cakes may be fed advantageously during critical brood-rearing periods early in the spring. It must be recognized that strong colonies developed because of early brood production will require larger quantities of honey than those held back in development until pollen can be collected. However, strong colonies may replace the honey consumed during the winter from early flows, which only sustain the smaller colonies, and they will yield a much larger surplus during the main flow.

Soybean flour cakes containing 25 percent of pollen are most practical in regulating early-spring brood production. A higher percentage of pollen may increase brood production, but with a limited supply of pollen, cakes of 75 percent of soybean flour will permit practical brood production in more colonies at a lower cost per bee. The cost of dry bulk pollen may be estimated at 50 cents and soybean flour at 5 cents per pound. One pound of 75 percent of soybean flour and 25 percent of pollen will develop 7,000 to 7,500 bees at a cost of $16\frac{1}{4}$ cents, while one pound of 50 percent of soybean flour and 50 percent of pollen will develop 5,500 to 6,000 bees at a cost of $27\frac{1}{2}$ cents. The inverse relation between the number of bees reared and the quantity of food required per bee has been discussed previously. Cakes containing 25 percent of pollen remain in a palatable condition longer than those containing less pollen.

The pollen trapped from one good colony should provide a sufficient quantity, when mixed with 75 percent of soybean flour, for approximately 50 colonies. It is economical to sacrifice the production of one colony in order to advance the development of 50 colonies during critical brood-rearing periods.

Where no bulk pollen is available, cakes made with soybean flour alone can be fed advantageously to colonies containing scattered pollen reserves in the combs; to colonies lacking pollen about 10 days prior to spring pollen collection; and in the spring when pollen collection is likely to be intermittent.

The formula for making fifty 1-pound cakes is as follows: 4 pounds of dry pollen is softened with 2½ cups of water. This moist pollen is added to 30 pounds of thick sugar syrup made by dissolving 20 pounds of sugar in 10 pounds of hot water. Twelve pounds of soybean flour is added to the syrup and pollen mixture and stirred until uniformly mixed to produce a doughlike paste. The pollen does not soften readily in sugar syrup but breaks up when a little water is added. Where the pollen supply is abundant and the percentage can be increased from 25 to 50 percent, less syrup will be needed; if soybean flour is used alone, more syrup will be required.

There are many grades of soybean flour on the market, many of which have not been tested as a pollen supplement. It is recommended that one be selected having a low fat content (0.5 to 2 percent) and containing approximately 50 percent of protein, refined by the heat-treated expeller process rather than by the chemical-extraction process.

Cakes of about 1 pound should be fed to each overwintered colony beginning March 10 to 20 in regions where the main honey flow begins in June. The hive cover should be removed and the bees smoked down below the top bars. The soybean-pollen paste flattened out into cakes about one-half inch thick should be placed on the top bars directly over the center of the cluster, and covered with waxed or paraffined paper to prevent drying. The inner cover should be inverted to provide space for the cake. New cakes should be added before the previous cakes are consumed. Generally 7- to 10-day intervals are satisfactory. For sustained brood rearing, a large feeding surface proportional to the colony strength is desirable. Package colonies deficient in pollen should be fed in the same manner.

Figure 1 shows a colony feeding on parts of two cakes. When the cakes have been consumed so that they no longer cover the brood nest, the bees should be smoked down and the pieces of the front cake pulled to one side to permit a new cake being placed over the center of the cluster.

Construction and Use of Pollen Traps

Pollen traps, which were designed for experimental control of pollen in colonies and collecting pollen for feeding tests, now have a practical use in productive colony management. Pollen traps are useful in determining the heavy pollen-yielding periods of a locality which will aid the beekeeper in applying manipulative practices to increase the storage of pollen reserves. They provide a means of collecting reserve pollen for supplemental feeding with soybean flour during critical periods in brood rearing, when colonies are unable to develop because of a pollen deficiency. By collecting pollen before it enters the hive, the danger of spreading disease is minimized, whereas distribution of pollen combs presents a risk which the beekeeper should be reluctant to take unless he is certain no disease exists in his locality.

A line drawing of the pollen trap is shown in figure 2. Figure 3 shows a pollen trap in position at the hive entrance. It will be noted that the bottom board must be raised several inches to hold the pollen trap off the ground. Figure 4 shows the shape and the dimensions of the pieces necessary to construct a pollen trap of this type.

The trap consists of a double grid of a 5-mesh hardware cloth, through which the bees must pass, which scrapes off the pollen pellets from their legs as they enter the hive. These pellets fall through a screen into the pollen tray beneath. The grid and the pollen tray are supported and protected by a storm shield which prevents rain from reaching the pollen and closes the entrance except through the grid. The principle used in this trap may be applied to any pollen trap which will compel the bees to pass through a 5-mesh grid, collect the pollen, and protect it from rain.

The grid of the trap is shown in figure 2 and the details of its construction are illustrated in the cross section of the pollen trap to the right of figure 2. The grid is constructed by folding a piece of 5-mesh hardware cloth to form a "U" approximately 2 inches deep with the two sides spaced 1/2 inch apart. The cut edges are turned at right angles to permit soldering to the storm shield, which is constructed from galvanized sheet iron. The bees' passing through the first side of the grid may only loosen the pollen pellets, but these will be dislodged in passing through the second. The pollen tray is constructed of wood and 1/8-inch masonite, with the length slightly less than the width of the hive, and with a cross section of approximately 3 by 3 inches. The tray is covered with 7-mesh or 8-mesh hardware cloth to exclude bees from entering the tray and to close the hive entrance except through the grid. The metal storm shield extends approximately 8 inches in front of the hive, with turned-in edges providing a support for the pollen tray. The roof of the shield is cut to allow 1/4 or 3/8 inch right-angle flange fitting inside the front of the hive body. The back of the storm shield, as shown in figure 2, should extend 1/4 inch above the hive floor to exclude water from the tray. Small wooden supporting blocks are used to fill the corners between the grid and the back of the shield. These blocks help to reinforce the ends of the grid and to permit the use of a pollen tray short enough to allow easy removal yet prevent the bees from entering at this point. A shade board, as shown in cross section to the right of figure 2, is used to prevent the storm shield from getting too hot under sunlight. The bottom board of the hive is pushed back even with the front of the hive, and a cleat or board is used to close the opening at the rear (see figure 3). The exact dimensions of the pollen trap will be determined by the size of the hive. Almost any of the dimensions given may be varied and the storm shield may be made of wood if desired. The principle to keep in mind is that the bees must be completely excluded from the hive except through a double 5-mesh grid and that a suitable receptacle be provided to collect the pollen and protect it from rain. Any number of variations in the construction of a pollen trap are possible.

Figure 5 shows a pollen trap in use on a hive. The hive must be raised above the ground level to allow space for the trap to hang free. The shallow rim with screened holes on two sides provides ventilation for the colony during hot weather. Ventilation may be provided equally well in the floor of the bottom board, provided the hive supports permit free circulation of air underneath the hive.

The bees usually require several days to become accustomed to the trap. The pollen trapped during the first week will be below normal, thus making it desirable to leave the traps on the same hives rather than shifting them to different hives in the apiary. Colonies equipped with pollen traps will rear some brood but brood rearing will be curtailed. They may be given combs of pollen from other colonies to keep up their production, but good colonies at the beginning of the season will survive and may produce some honey. They can be united at the end of the season.

Figure 6 shows a pollen tray, about two-thirds full of pollen, removed from the trap. The pollen should be removed every 2 or 3 days under ordinary conditions and more often when the humidity is high or when the pollen is unusually moist. The pollen should be spread out to a depth of 1/2 to 3/4 inch for air drying. To prevent molding, moist pollen can be dried rapidly in an improvised oven heated with electric light bulbs. The oven may be constructed from a large fiber carton equipped with a rack to support five or six trays which consist of wooden rims covered with cheesecloth. The pollen should be spread in a thin layer on the trays to allow the warm air which is generated at the bottom to pass through each tray and escape from an opening in the top of the oven.

When the pollen is dry enough to prevent caking, it should be stored in glass or metal containers to exclude moths. If it becomes infested, it should be fumigated with carbon disulfide. Thoroughly dried pollen stores well in 5-gallon honey cans. From 20 to 40 pounds of pollen may be collected from good colonies during the season. In the South even larger quantities may be collected.

Summary

Sufficient pollen may be trapped from one good colony which will provide a source of protein food, when supplemented by 75 percent of soybean flour, for 50 colonies that will sustain desirable brood rearing during the late winter and early spring. Brood production during this period enables the colony to replace the overwintering bees with young bees, so that when pollen becomes available in the field the colony will develop to a maximum population for the honey flow. Colonies lacking in reserve pollen or a substitute material, frequently pass through a period of spring dwindling which results in the colony reaching its maximum population after the honey flow. Profitable honey yields are produced by those colonies which have maximum populations throughout the honey-flow period.

Soybean flour supplemented by 25 percent of pollen is equally useful in developing new colonies from package bees. The packages can be established earlier because they need not be dependent upon favorable weather for pollen collection from the field in order to carry on rapid brood production.

There are no known complete substitutes for pollen. It is therefore necessary to trap the pollen at least a season in advance of when it is to be fed. The collected pollen must be dried and stored in moth-proof containers until needed. Where no collected pollen is available, cakes of soybean flour may be fed advantageously about 2 weeks prior to the normal spring pollen collection or early in the spring when its collection is intermittent because of inclement weather.

Figure 1.--Winter cluster feeding on cakes made from pollen and soybean flour. This colony is ready for a new cake to be placed over the center of the cluster to insure an adequate feeding surface.

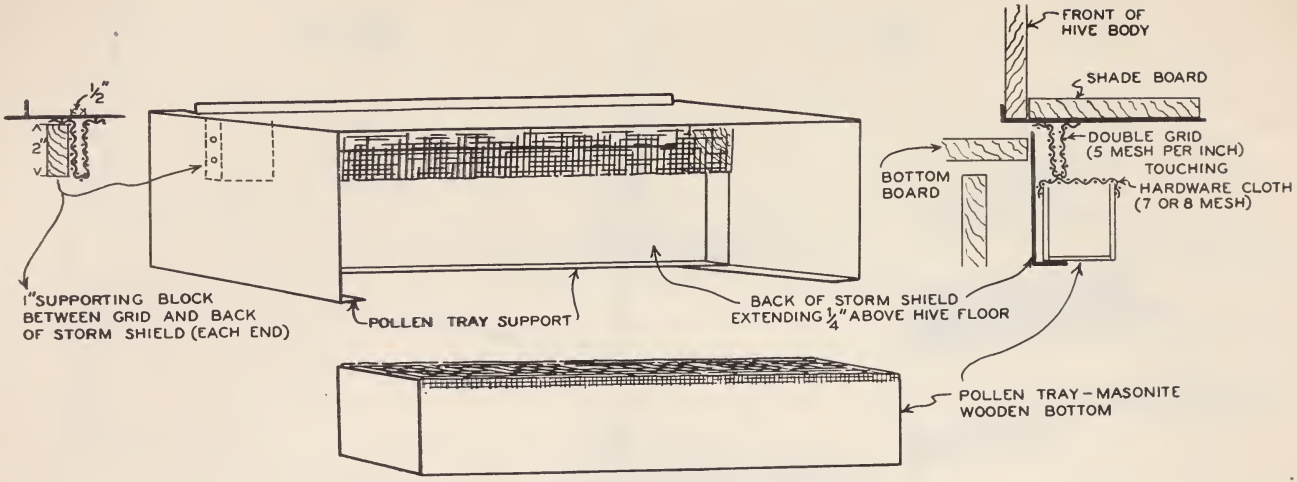

FIG. 2 – LINE DRAWING OF DETAILS OF POLLEN TRAP.

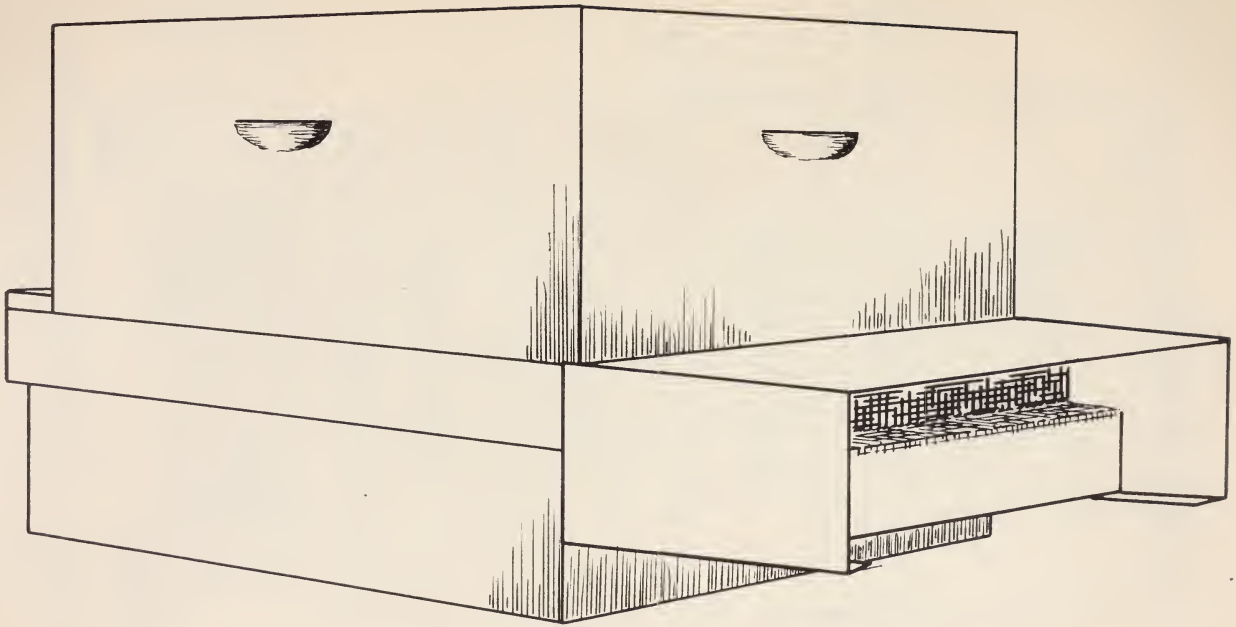

FIG. 3 - POLLEN TRAP IN POSITION AT ENTRANCE OF TEN-FRAME HIVE.

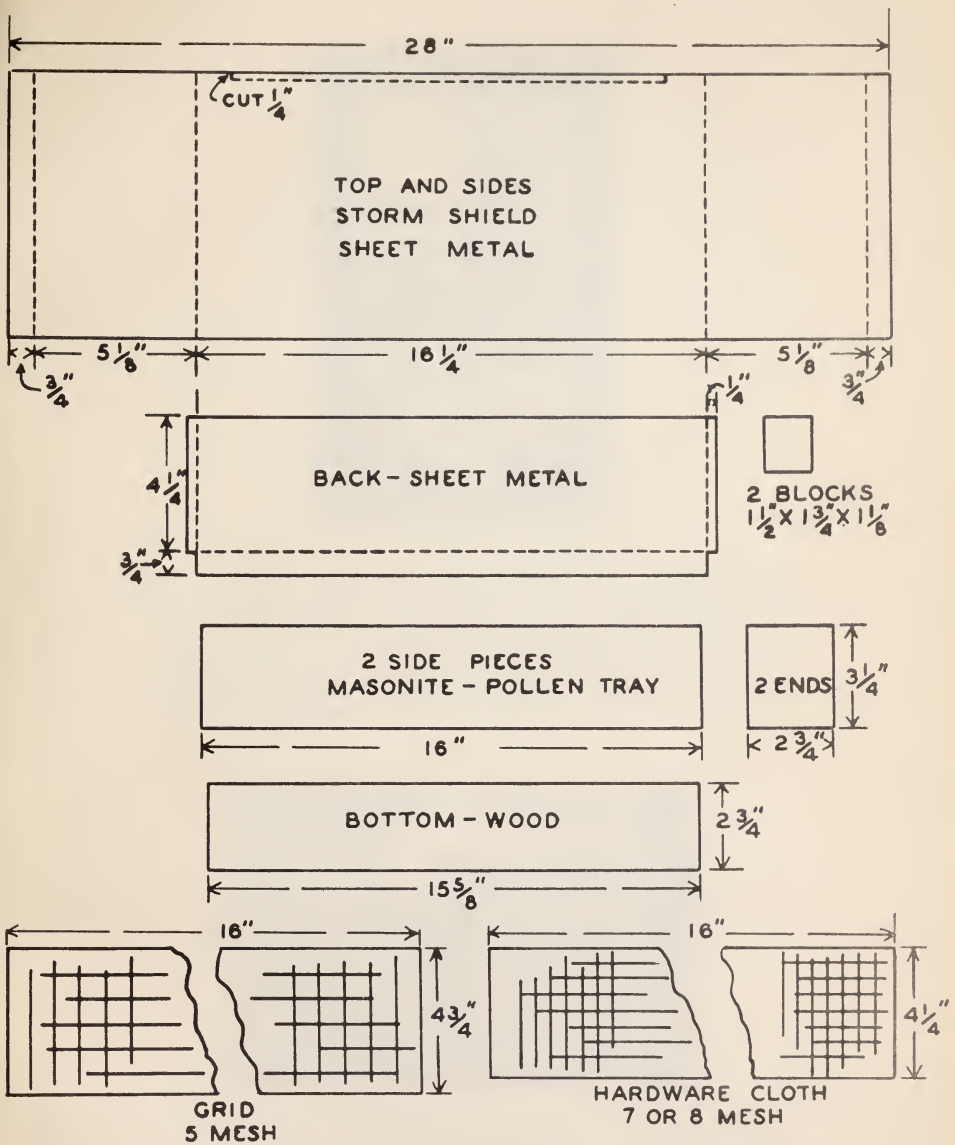

FIG. 4 - SHAPE AND DIMENSIONS OF PIECES NEEDED TO CONSTRUCT A POLLEN TRAP.

Figure 5.--Hive equipped with a pollen trap, showing a shade board on top of the storm shield, a cleat closing the rear end of the bottom board which projects because the hive is placed forward to accommodate the trap, and a shallow ventilating rim which has a screened opening on both sides. The hive rests on a suitable support to allow the pollen trays to hang free.

Figure 6.--Pollen tray removed from trap. Approximately 24 ounces of pollen is shown in the tray.